Effect of Blood Flow Restriction Training on Pain, Agility and Electromyographic Muscle Activity among Collegiate Recreational Runner with Medial Tibial Stress Syndrome: A Randomized Controlled Trial

By

Sanghamitra Jena

Roll. No.: 532

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Lakshmibai National Institute of Physical Education Gwalior (MP), India.

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Abstract

Background:

Medial Tibial Stress Syndrome (MTSS) is a prevalent overuse injury among collegiate runners, often resulting in pain and functional limitations. Blood Flow Restriction (BFR) training, which involves low-load exercise combined with vascular occlusion, has shown potential in improving muscle function and reducing pain in various populations. However, its effects on MTSS have not been thoroughly explored.

Objective:

This study aims to evaluate the effect of BFR training on pain levels, agility performance, and electromyographic (EMG) muscle activity in collegiate recreational runners diagnosed with MTSS.

Methods:

A randomized controlled trial will be conducted involving estimated sample size of 72 With an addition of 10% dropout rates, the final sample size calculated by using G power was 80 collegiate recreational runners with MTSS. Participants will be randomly assigned to either a BFR training group or a control group. Both groups will undergo an 8-week intervention program. Group A will perform BFR combined with low-load resistance training by using theraband. Group B will receive standard physiotherapy care with resistance training without BFR. Outcome measures will include the pressure algometer for pain, T-test for agility, and electromyography (EMG) to assess muscle activity in the tibialis anterior and tibialis posterior. Assessments will be performed at baseline and after 8 weeks of intervention.

Expected Results: It is hypothesized that the BFR training group will demonstrate greater reductions in pain, improvements in agility and increased EMG activity compared to the control group.

Conclusion: This study is expected to provide evidence on the effectiveness of BFR training as a rehabilitation tool for collegiate runners with MTSS, potentially guiding future clinical practice in sports injury management.

Keywords: Medial tibial stress syndrome, Pain, Recreational runner, Agility, College Student, Muscle activity

Introduction

Medial Tibial Stress Syndrome (MTSS) is a musculoskeletal injury of the lower leg caused by stress reactions in the tibia and surrounding muscles due to repetitive muscle contractions and tibial strain linked to running and walking activities. It is an exercise-induced overuse injury in the lower leg pain

usually manifests along with the distal third of the posterior medial tibial border and is provoked upon palpation over an area of five consecutive centimetres. Most of the time, recreational runners face musculoskeletal injuries due to poor biomechanics and lack of pre-competition training.

Blood flow restriction (BFR) training has emerged as a promising technique that has shown potential benefits in enhancing muscular strength and promoting tissue adaptation. BFR-RE can produce greater results than low-load resistance exercise (LL-RE) in muscle hypertrophy and strength adaptations. This study protocol aims to investigate the effect of blood flow restriction training pain, agility and electromyographic muscle activity among collegiate recreational runners with medial tibial stress syndrome.

STATEMENT OF THE PROBLEM

The purpose of the study is to investigate the effect of Blood Flow Restriction Training on pain, agility and electromyographic muscle activity among collegiate recreational runner with medial tibial stress syndrome.

OBJECTIVES OF THE STUDY

- To evaluate the effect of Blood Flow Restriction Training on pain, agility and electromyographic muscle activity among collegiate recreational runner with medial tibial stress syndrome.
- To identify the significant difference between the experimental group and the control group in collegiate recreational runner with medial tibial stress syndrome

RESEARCH QUESTION

- Is there any significant effect of blood flow restricted training on pain, agility and electromyographic muscle activity among collegiate recreational runner with medial tibial stress syndrome.

HYPOTHESES

Alternate Hypothesis

- It is hypothesized that Blood flow restricted training will have a significant impact on pain, agility and electromyographic muscle activity among collegiate recreational runner with medial tibial stress syndrome

DELIMITATIONS

- The study is delimited to the both male and female age between 18-30 years.
- The study is delimited to recreational runners experiencing symptoms for more than two weeks.
- Pain localized to anterior and posteromedial sides of the shin and local tenderness as I and II
- The diagnosis of MTSS will be confirmed through physical test by One leg Hop test and Yate's criteria.
- This study is further delimited to 8 weeks intervention.
- Individual with fracture in the lower limb, surgery around knee and ankle, bone pathology, deformities and any neurological disease will be excluded from the study.

DEFINITION AND EXPLANATION OF TERMS

Blood Flow Restricted Training

A training method that restricts blood flow in working musculature with low-intensity exercise. BFR technique involves applying an external pressure using a tourniquet cuff to the upper and/or lower limbs. The cuff becomes inflated as a result, while gradually compressing the blood vessels underneath it. This hampers the normal blood flow within the cuff by partially restricting the arterial blood flow and severely affecting the venous outflow. The end results of BFR include poor oxygen supply (hypoxia) within the muscle tissue and blood pooling (venous Insufficiency) within the capillaries. Generally, the blood pooling occurs in occluded limbs.

Agility

Agility is one of the performance-related components of physical fitness. It is defined as "a rapid whole-body movement with change of velocity or direction in response to a stimulus" by Shepperd and Young, 2005.

Recreational Runners

Recreational sports include all kind of physical activities, played for fun, participation, or aiming at social engagement. Recreational activities are believed to be less psychologically or physically demanding as expectancies regarding performance and commitment to the sport are lower, compared with competitive sports. However, despite the positive effect of recreational sports to physical and mental health, related injuries occur frequently

Medial tibial stress syndrome

MTSS refers to pain on the anterior and posteromedial tibial border during exercise which is reproduced with palpation of the tibia over a length of at least 5 cm.[15] Yates and White defined MTSS as "pain along the posteromedial border of tibia that occurs during exercise.

EMG Analysis

Electromyography (EMG): EMG is an experimental technique concerned with the development, recording and analysis of myoelectric signals.

Pain

Pain is an unpleasant sensory and emotional experience that is associated with actual and potential tissue damage. (International Association for the study of pain, 1994)

SIGNIFICANCE OF THE STUDY

- This study may be useful for athletes for reducing injury and returning to sports.
- The study may help in the management of MTSS to reduce pain and improve function.

REVIEW OF LITERATURE

Sl.no	Author and year	Sample and research	Protocol	Outcome variables	Result

		design			
1.	Ladlow P, Coppack RJ, Dharm-Datta S, Conway D, Sellon E, Patterson SD, Bennett AN.,2018 Sep 10	Twenty-eight lower-limb injured adults, RCT	low-load resistance training with blood flow restriction	Muscle cross-sectional area (CSA) and volume, muscle strength, leg press and knee extension test, isometric hip extension], pain and physical function measures (Ybalance test, multistage locomotion test—MSLT).	Comparable improvements in muscle strength and hypertrophy were shown in LL-BFR and conventional training groups following in-patient rehabilitation
2.	Patterson SD, Hughes L, Warmington S, Burr J, Scott BR, Owens J, Abe T, Nielsen JL, Libardi CA, Laurentino G, Neto GR. 2019:533.	Review Article	-	-	The aim of this article was to give an overview of the adaptations to different modes of BFR, methods of application and the safety considerations.
3.	Newsham K, Boyd M, Lauber C.,2023.	27, Intercollegiate athlete	Neuromuscular intervention • Phase 1 (days 1 and 2) • Phase 2 Initiate manual resistance and SFE; continue with phase 1 exercises (days 3-5) • Phase 3 Initiate functional activity and continue with slant board stretching (days 8-14)	Pain-11-point numeric rating scale, pressure-pain threshold- algometer, Foot and Ankle Ability Measure	This study demonstrates a neuromuscular-based intervention aimed at relieving soft tissue tenderness in the deep compartment and improving IFM function provides significant and sustained relief of leg pain.
4.	Eduardo D. S. Freitas1, Ryan M. Miller1, Aaron D. Heishman1 et.al.,2020	Four men and eleven women diagnosed with relapsing-remitting MS	BFR-RE– four sets of 30-15-15-15 repetitions	1.Ratings of Perceived Exertion (RPE) 2.Ratings of Discomfort and Delayed-Onset Muscle Soreness (DOMS)	These data demonstrate that LLBFR-RE is well tolerated by MS patients, requires less muscular exertion than HLRE.
5.	Rutika Vavekar and Dr. Tejas Borkar.,2022	60 participants of age group 12- 15 years, Cross-sectional study	This study was to check prevalence of MTSS in group of secondary high school sports	Ankle- range of motion, manual muscle testing for soleus and tibialis posterior and Foot posture index	Prevalence was found more in males than in females. Pronatory foot type was notably

			players, to compare if prevalence was more in males or females and check association between foot posture and MTSS.		associated with presence of Medial Tibial Stress Syndrome

METHODS AND MATERIALS

Dependent variables – Pain, Muscle Activity and Agility

Independent variables- Blood Flow Restricted Training with low intensity resistance Exercise

Criterion Measure

- Pain- Pressure Algometer
- Agility- Agility T test
- Muscle activity- EMG

Design of the study

This study will be a prospective randomized active controlled trail to be done at Galgotias University.

Administration of test

Pain- Pressure algometer has been widely employed to evaluate myofascial pain syndrome and various musculoskeletal diseases. The reliability of pressure pain thresholds according to raters or measurement frequencies is relatively high. Pressure pain thresholds measurement will be taken for Tibialis anterior and posterior muscle. We place the digital pressure algometer on a site to be inspected and press against the tester in a vertical direction .

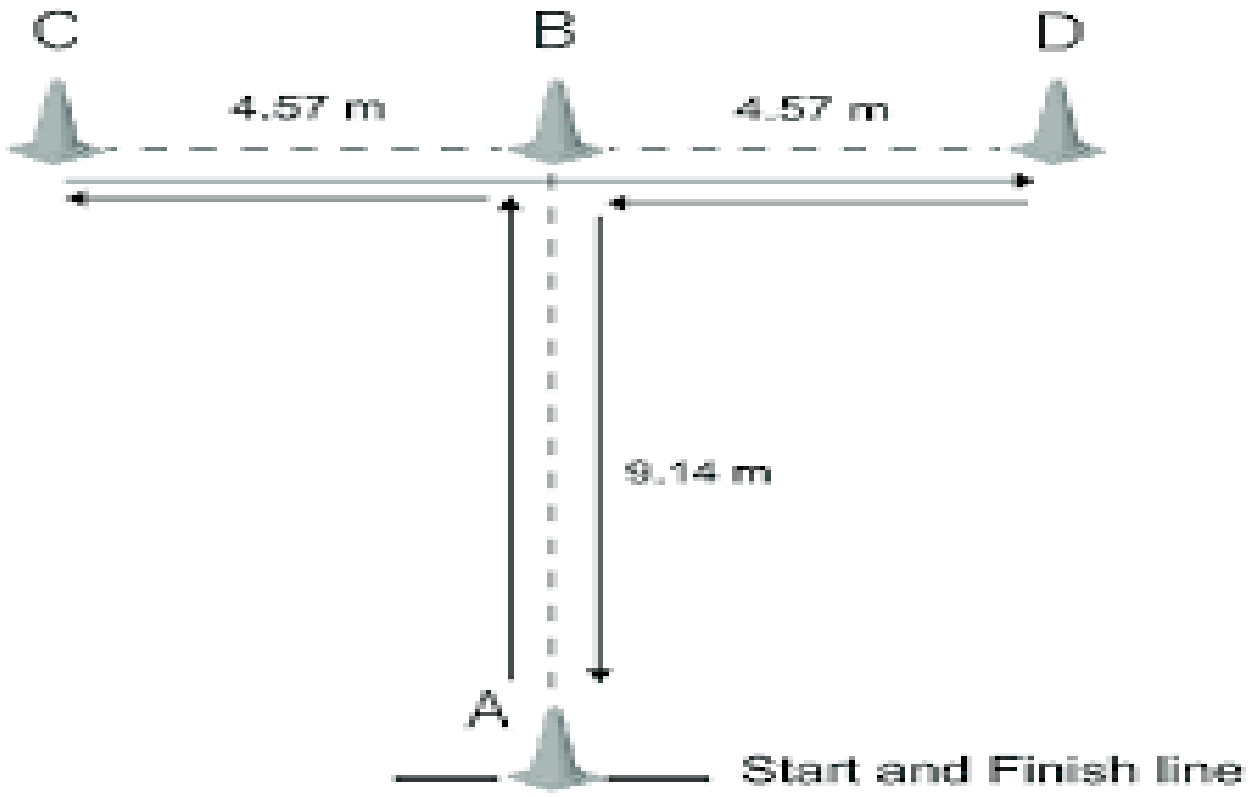
Muscle activity

Prior to the experimental phase, each subject will be prepared for EMG recording . The electrodes Will be attached parallel to the muscle fiber orientation, unilaterally. EMG electrodes will be placed for Tibialis anterior and posterior. Then EMG activity will be recorded for both muscles.

Agility

The T-Test is one of the most important agility test and this is a combination of different sport specific pattern as forward, lateral and backward movements. Subjects will be asked to sprint forwards 9.14 m from the start line to the first cone and touch the tip with their right hand, shuffle 4.57 m left to the

second cone and touch with their left hand, then shuffle 9.14 m to the right to the third cone and touch with their right, shuffle 4.57 m back left to the middle cone and touch with their left hand before finally back pedaling to the start line. Time starts upon subjects passing through the timing gates and stops upon them passing through on return. The test will not be counted if the subject crosses one foot in front of the other while shuffling, fails to touch the base of the cones, or fails to face forward throughout the test. Take the best time of three successful trials.

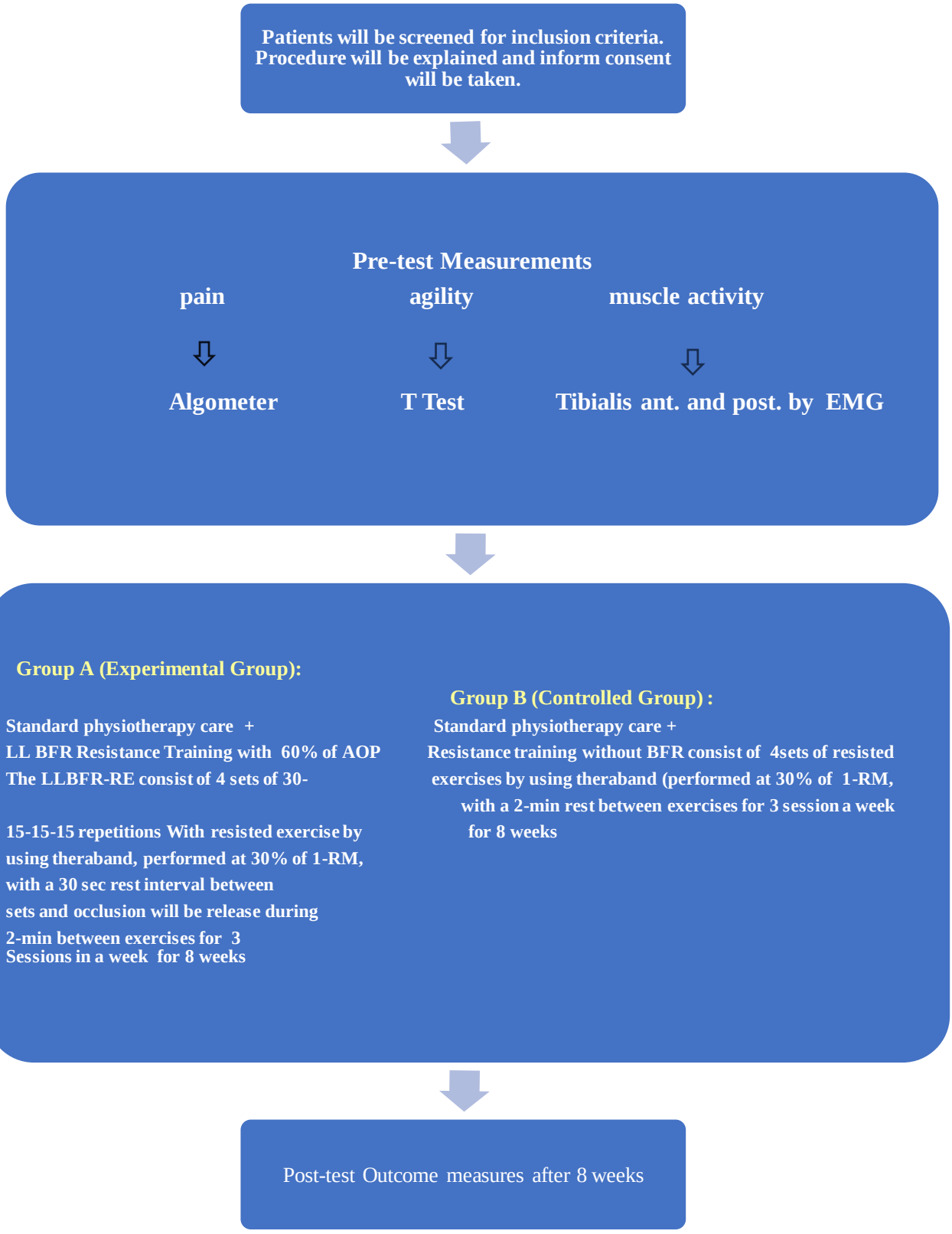


Procedure for collection of data

- Collegiate recreational runners with complaint of exercise-related anterior and posteromedial medial leg pain consistent with MTSS and experiencing symptoms for more than two weeks duration will be screened. After obtaining informed consent, the participants will be randomly allocated in 1:1 ratio to the BFR training group and the control group using a computer-generated randomization sequence.
- Study design: This study will be a prospective randomized active controlled trial to be done at Galgotias University.

  Sample size calculation:

  Using G* Power version 3.1.9.4, the sample size was calculated using the mean difference between two independent groups (with an effect size of 0.6 and margin of error kept at 0.05% with 80% power and an allocation ratio N2/N1;1, the minimum estimated sample size was calculated to 72. With an addition of 10% dropout rates, the final sample size calculated was 80.
- **Study Settings:** Galgotias University
- **Duration study**: 8 Weeks (Base line & at the end of 8 Weeks)


Patients will be screened for inclusion criteria. Procedure will be explained and inform consent will be taken.
Pre-test Measurements
pain
agility
muscle activity
Algometer
T Test
Tibialis ant. and post. by EMG
Group A (Experimental Group):
Standard physiotherapy care +
LL BFR Resistance Training with 60% of AOP
The LLBFR-RE consist of 4 sets of 30-
15-15-15 repetitions With resisted exercise by using theraband, performed at 30% of 1-RM, with a 30 sec rest interval between sets and occlusion will be release during 2-min between exercises for 3 Sessions in a week for 8 weeks
Group B (Controlled Group) :
Standard physiotherapy care +
Resistance training without BFR consist of 4sets of resisted exercises by using theraband (performed at 30% of 1-RM, with a 2-min rest between exercises for 3 session a week for 8 weeks
Post-test Outcome measures after 8 weeks

Intervention

Subjects will be allocated into group A & B. After screening will be done, we will moniter the vitals. Group A will be the experimental group that will receive Blood Flow Restriction with resistance training (low load) exercises by using the theraband of plantar flexor, dorsiflexor, evertor and invertor muscles whereas Group B will be the Control group that will receive the resistance training without Blood Flow restriction by using theraband.

Group-A

A 10-cm wide contoured blood pressure cuff was placed around the proximal end of each thigh and inflated to the pre-determined 60% AOP. Participants performed BFR combined with low-load Resistance training (30% 1-RM).

Pneumatic cuffs with inflator

Model of exercise prescription with BFR-RE. Guidelines

Frequency day (1–3 weeks	2–3 times a week (>3 weeks) or 1–2 times per
Load	20–40% 1RM
Restriction time exercises)	5–10 min per exercise (reperfusion between
Type legs/uni or bilateral)	Small and large muscle groups (arms and
Sets	2–4
Cuff (large)	5 (small), 10 or 12 (medium), 17 or 18 cm
Repetitions Pressure AOP	(75 reps) – 30 × 15 × 15 × 15, or sets to failure
Rest between sets	30–60 s
Restriction form	Continuous or intermittent
Execution speed	1–2 s (concentric and eccentric)
Execution scheme is completed	Until concentric failure or when planned rep

Group B (Control group)

Standard physiotherapy care with resistance training without Blood Flow restriction. After Gentle Warm up subjects will start low load resistance training by using theraband for plantar flexors, Dorsiflexors, Invertors and evertors.

Expected Results: It is hypothesized that the BFR training group will demonstrate greater reductions in pain, improvements in agility and increased EMG activity compared to the control group.

Conclusion: This study is expected to provide evidence on the effectiveness of BFR training as a rehabilitation tool for collegiate runners with MTSS, potentially guiding future clinical practice in sports injury management.

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